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Mobility as a Service: Opportunities in the City of Austin

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Mobility as a Service: Opportunities in the City of Austin

by

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Report

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Abstract

Mobility as a Service: Opportunities in the City of Austin

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Mobility services are quickly and continually evolving, propelled by advancements in technology, leading towards improved convenience and seamless transition between mobility providers. Mobility providers and 3rd party organizations are evolving towards cross-compatibility of services, including planning and payment over a single platform, this is called mobility as a service (MaaS). Austin, Texas has been facing the challenges of an urban fabric dependent on personal vehicles for mobility, including traffic congestion, reductions in air quality, and a disproportionate burden on marginalized communities. Adoption and enhancement of MaaS platforms within the city of Austin can relieve reliance on personal vehicles and ultimately improve residential quality of life. Still an evolving technology, existing studies have proposed structures and infrastructure that need to be in place for successful MaaS deployment, though none have looked at opportunities within Austin, which this project seeks to find. Through evaluation of existing City of Austin planning documents, proposed frameworks for deployment by researchers, and

understanding of existing and proposed plans for MaaS platforms, this work seeks to understand the viability and roadmap for deployment within Austin. Results place Austin very well equipped to produce and handle and functioning MaaS platform by utilizing existing infrastructural pieces and planned mobility development, these include the number of mobility alternatives, a robust public transit service and planned increases in density. This report provides context for both policies and infrastructure that is necessary for cities to implement a successful MaaS platform.

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Chapter 1: Introduction to MaaS

Mobility as a Service (MaaS) is a concept that is still developing in cities around the world. MaaS centers itself around utilizing multiple mobility services across any mode available to move people to their destination seamlessly, through a single platform with integrated payment. The goal for MaaS is to play a significant role in aiding and encouraging travel through methods other than personal vehicles and reduce such dependence (MaaS Alliance). Although MaaS has ambitious goals and substantial potential, there are many obstacles to its effective implementation. This PR aims to address the complexities involved in deploying and operating a MaaS platform, including stakeholder collaboration, policy considerations, and cultural attributes. Highlighting specific opportunities MaaS can achieve, while noting barriers to implementation this PR looks to Austin as a potential site for MaaS deployment.

Like most American cities, Austin, Texas developed in a time built for the automobile. Beginning with multiple Federal Highway Acts, encouraging development of America's roadway infrastructure, and post WWII suburbanization movements the stage was set for sprawl. Through continued development practices and unaltered policies these standards continue today (Eschner K., 2017). These development patterns promote personal vehicle use and result in few opportunities for residents to choose transportation methods other than their personal vehicles. These habits can result in increased traffic congestion, worsened environmental quality through air pollution, and reduced livability

Figure 1: Auto Centric Development in Austin. Source: AQUILA Commercial

within a city. Figure 1 above depicts the induced traffic demand that has resulted in Austin from urban development patterns prioritizing personal vehicles.

Austin is already one of the largest cities in the nation, nearing 1 million residents and a metro area of over 2 million. Austin is also one of the fastest growing cities in the nation, with a rate of population growth between 2007 to 2017 at 31.4%, surpassing the rate for the state of Texas (18.8%) and for the US (8.0%) (Texas State Data Center, 2018). With this in mind, addressing the concerns mentioned previously is of increasing importance to manage early as Austin is in a time of significant growth where, unless addressed, will result in increasing vehicle traffic, roadway congestion, air pollution, and ultimately reductions in quality of life. The city of Austin considers itself a model for livability and lauds itself on great economic opportunities, and its willingness to remain "smart" and adaptive to the world around it. Described in the Imagine Austin Comprehensive Plan, the city holds six goals for the future of its development including 1. Preserving livability, 2. Expanding transportation choices, 3. Tackling the ethnic divide, 4.

Protecting natural resources, 5. Promoting prosperity for all, and 6. Collaborating regionally (Austin City Council, 2012). Implemented thoughtfully, comprehensively, and holistically MaaS can help achieve and aid many of these goals.

Though continually evolving, within the scope of this paper MaaS is defined as a single platform that includes all available mobility options within a municipality that a user can use for the entirety of planning and payment of a journey. Austin could benefit greatly from embracing MaaS, many of these benefits would assist or directly encourage the aims the city seeks to achieve in its' comprehensive plan, particularly in terms of congestion and environmental goals, livability, and mobility equity. Public agencies look at MaaS as an opportunity to reduce the need for and number of private cars on the road through enhanced mobility variety and opportunities. Through a reduction of roadway congestion and subsequent air quality improvements, and roadway efficiency, benefits in livability are to be found. Lastly, MaaS can provide affordable and comprehensive service to all regions of a city, including the population unable to drive, like youth and senior citizens, a frequent concern in mobility equity. MaaS has the potential to induce great benefits in mobility for cities. This PR reviews the concepts and components necessary of MaaS, the critical elements that must be in place as well as hurdles and uncertainties that lie ahead, and the potential factors that foster successful collaboration. Looking at case studies and opportunities and challenges specific to Austin, this PR aims to synthesize essential factors necessary for MaaS implementation and evaluates what is the potential for a functional MaaS service in the city and region of Austin, and what steps can be taken for its development.

Chapter 2: MaaS: Critical Elements and Considerations

The many barriers and uncertainties posed by the development of MaaS present substantial need and opportunities for planners not only to acknowledge these hurdles, but to act on them to ease the process for MaaS implementation. These considerations range from changes in physical infrastructure of a city, to structural changes within city organization. MaaS is unique in that it is an evolving technology that has a limited precedent to base an implementation plan from. Further existing barriers, including data standards and cross-boundary authority coordination that make MaaS deployment difficult. This chapter will investigate the necessary pieces that are essential for a successful MaaS deployment, including steps for achieving them.

As an emerging and evolving technology many public agencies are working to adapt and understand both functionality and capabilities this platform can offer. Figure 2 below provides a basic illustration of the ability a MaaS platform holds, access to several mobility opportunities within one application. Several definitions exist, posed by

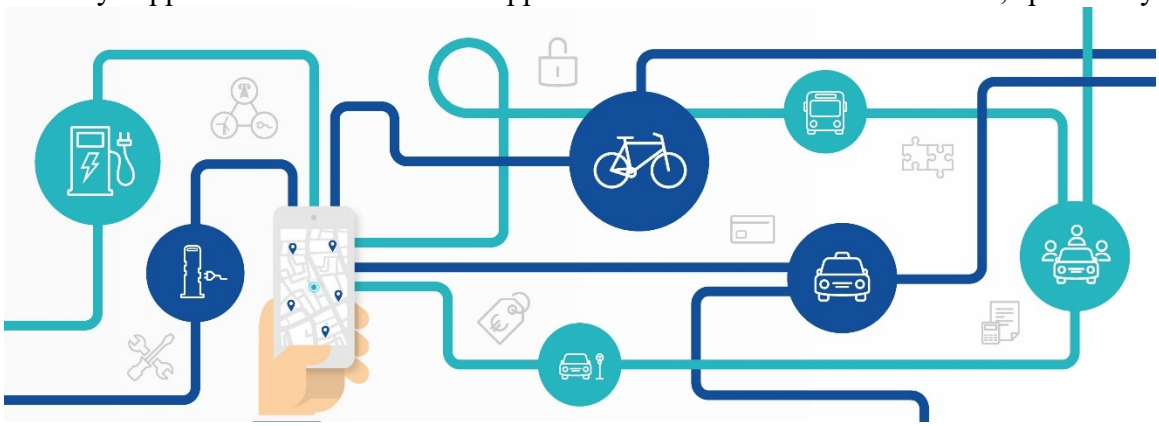

Figure 2. Mobility As a Service Illustration. Source: Medium.com

researchers and mobility agencies and, though similar, this variation creates a difficult foundation for launching a service as sweeping as MaaS. “It combines different transport modes to offer a tailored mobility package, similar to a monthly mobile phone contract and includes other complementary services, such as trip planning, reservation, and payments, through a single interface.” (Jittrapirom et al. 2017). “The concept of MaaS is to use a single app to access and pay for various transport modes within a city or beyond; and the app will give options to allow a traveler to select the most suitable transport mode” (Li, Y. and Voege, T., 2017). “MaaS is the integration of various forms of transport services into a single mobility service, accessible on demand” (MaaS Alliance). What all these definitions all have in common is a single platform that allows users to access all mobility options to and from a designated area, as well as related services like payments and trip planning. Because of this lack of clarity from the onset, when deploying MaaS, establishing the end goals you hope to see at the beginning are pivotal to forming a MaaS platform.

In tandem with formulating a working definition for MaaS, what is still developing is the “so what”, why cities are pushing so hard for this platform. It boils down to establishing MaaS as a simple platform that is even easier than using one’s own car. Driving for most people is simply the easiest option, and there may be too many hurdles for people to willingly adopt public transit at this time. The existing transportation system is inefficient, between rideshare, public transportation, and individual vehicles, there is substantial capacity to move many people, it just isn’t being utilized fully (Humanes, P., et al. 2019). Particularly in American cities, public transit ridership is very low, and this is a result of both policies, infrastructure, and development standards that focus on personal

vehicle dependent development. Infrastructure and policies are also often complimented by poor public transit networks and limitations in necessary infrastructural pieces, like sidewalks or comfortable bus stations. Because public transit is often fragmented in American cities, many don't offer a mobile or online platform, or can only take cash or pre-paid cards, so many residents resort to third party platforms like Google for information (Li, Y. and Voege, T. 2017).

UTILIZING EXISTING CAPACITIES

Public transportation is a vital piece for MaaS, offering substantial existing capacity that is not fully utilized. Often, just 50% of a public transit fleet is still able to serve 80% of existing demand. This inefficiency in roadway capacity provides a significant opportunity for encouraging MaaS and the benefits it can bring in terms of mobility and congestion reduction (Humanes, P., et al. 2019). Figure 3 below displays efforts the City of Austin has made to redistribute the use of space on the city's roadway towards prioritization of bus and bicycle use. The very beginning of MaaS systems are present in

Figure 3. Redistribution of Road Space in Austin, TX. Source: autintexas.gov

many cities, this is seen in transportation systems that use “smart cards” as a method for payment integration. Riders can pre-load these cards with money to use to begin and complete their journey on public transit. Smart cards show promise for a successful future of integration of payments, though for payments to be integrated across mobility modes, enhancements in internet communication technology (ICT) are vital (Humanes, P., et al. 2019). These early technologies are present in several transportation systems around the country and are the first iteration of coordinated technologies that can serve as additional convenience for users.

POLICY OPPORTUNITIES

Though, the digital platform is only part of the service, there needs to be the necessary infrastructure in place to serve these increased mobility needs. This infrastructure quality needs to be enhanced and comprehensive so people will feel comfortable and safe using these services. Beginning with physical changes that can be made within a city truly comes down to decreasing the necessity and convenience for residents to rely on a personal vehicle. Creating a platform, like an app or website, that offers all mobility opportunities within the city will not be enough to encourage drivers out of their cars unless it is made less convenient to do so and alternatives are enhanced. Potential policies would fund public transit, increasing routes and frequency or dedicating lanes for transit only. Following, establishing traffic calming measures or narrower car lanes can foster the mentality that strictly personal vehicles are not entitled to the roadway. Following, when planning new developments, policies like reducing or eliminating parking

minimums in a central business district, or on central corridors can encourage businesses to partner with transit agencies for paid employee transit (Humanes, P., et al. 2019). These policies need to move beyond strictly limiting personal vehicles and encouraging public transit, but to encouraging all modes of mobility as well. Figure 4 above displays this encouragement by providing a well-marked, comfortable, and protected bicycling experience for users. Further, plan to place bike share and scooters near high capacity transit stations to foster the seamless connection that makes MaaS more convenient. Lastly, when planning the physical development of cities density is vital. Density in cities inherently creates amenities closer to one another, establishing walking or biking/scootering as a more viable option (Goffman 2020).

Figure 4. Bicycle Focused Development, Austin. Source: ourstreetsmpls.org

MULTIPLE FACETS OF PLANNING FOR MAAS

For stakeholders developing MaaS, having a thorough understanding of both the comprehensive and nuanced nature of the community and of the dynamic evolution of the technology is one of the most important ways to establish baseline information to create goals that MaaS can achieve. This can begin as high as understanding national trends, where it is estimated that in the year 2020 car ownership levels are going to peak and begin

to fall after that (Li 2017). By understanding the services that exist already it may be possible to build off what already exists to foster an easier transition into MaaS services. Further, understanding the dynamic relationship and goals of the several organizing members at play is vital for setting the targets MaaS can achieve. Between governments, transport authorities, other mobility providers, and operators, expected outcomes of MaaS are going to differ, and understanding these desired outcomes is vital for productive collaboration and effective goal setting (Mehmet 2019).

MaaS is such a multifaceted platform that includes a wide variety of stakeholders, including "transport operators, data providers, technology and platform providers, ICT infrastructure, insurance companies, regulatory organization, universities, research institutions, and other media, marketing, and advertising firms" (Arias-Molinares and Garcia-Palomares. 2020). Because there are so many players involved it is important to not only work together but trust each other so that these partnerships can produce the best possible result for the community this platform is planned for. This mutual trust and collaboration is important because of the potential for power grabbing or organizations' fear of giving up power because of as part of these partnerships. To ensure an equitable platform is established proper and effective public/private collaboration standards need to be set, standardized data formats and other general regulations and individual responsibilities need to be determined at the onset (Mehmet, 2019). Power holds in MaaS organization can fluctuate substantially, three common organization methods include market-drive, public-controlled, and public-private. There are positives and negatives to leaning too far either way along this spectrum, where substantial regulation could impede

the private sector, whereas too little regulation may result in a product that does not service public interest (Arias-Molinares and Garcia-Palomares, 2020). Not only is trust between mobility providers and project planners important, it is also vital that the users hold this trust as well. Users must have assurance that the services provided are of the best quality and that the platform itself serves their interests, including protected information and data accessibility (Mehmet, 2019).

DATA AS A CRITICAL FOUNDATIONAL ELEMENT

An important framework for effectively deploying MaaS, and other mobility, services is an agreement to share data between cities and mobility service providers, which Austin has already done in the context of micro-mobility. Little direction provided by the national government has left much of this work to be done on a city by city level. One reason for the success in Finland's implementation of MaaS is the nation's net neutrality, whereas data standards in the US are much more complicated. Particularly unique within the US are variations on net neutrality principles between federal and state/local standards. Sharing of data is vital for cities to properly plan both short and long term for mobility solutions. Having information on where most scooter or bikeshare trips are taken, or what transit stations are most popular, can significantly benefit planning opportunities to capitalize on such trends (Jittrapirom, P., et al. 2018). Los Angeles was one of the first cities to establish a platform to be used across agencies as a method of collecting and utilizing private sector data, a platform called Mobility Data Specification (MDS), used to manage dockless

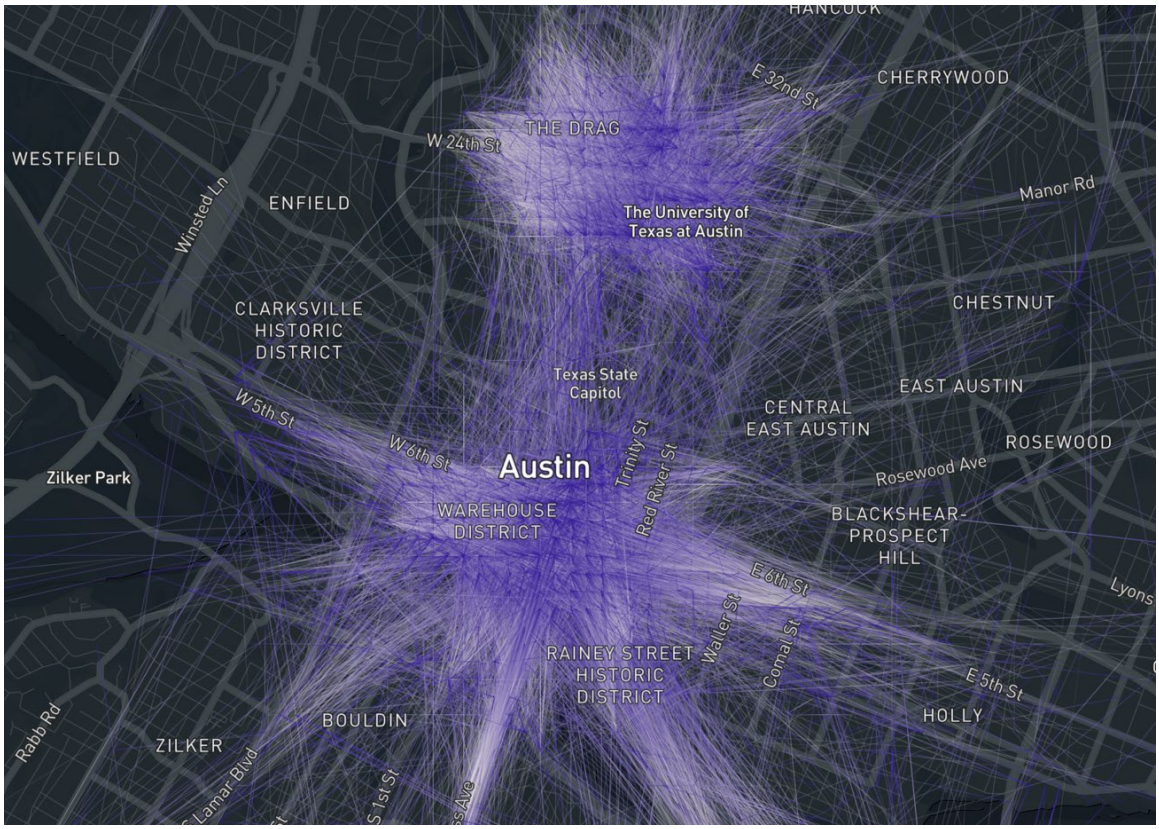

Figure 5. Austin Scooter Data. Source: medium.com

micro-mobility services. Figure 5 above presents the information that was gathered by the first year of dockless scooter use in Austin, presenting substantial information for future transportation planning. MDS has evolved to spur the creation of the Open Mobility Foundation (OMF). OMF is a program that is made up of several city leaders across the US, and the world, that uses MDS, or a portion of the MDS platform that fits the needs of their city. This platform establishes a standardized platform for two-way communication among public and private agencies with regards to information sharing, data collection, and decisions on public policies (Open Mobility Foundation).

ADDRESSING EQUITY

Structural changes are necessary within state and local governments to foster MaaS development, and that begins with ensuring transportation is, and can remain, equitable. When transportation services are cut or limited in some way, the impact is disproportionately felt by some groups in society more than others. Cuts in mobility opportunities are felt hardest by those that have fewer options to begin with, often residents of lower income, the elderly, or those suffering from a disability. Since American cities are built for mobility central to personal vehicles, limited or no access to one can be a significant detriment. While MaaS can aid this transportation inequity, it needs to be implemented methodically and with this inequity in mind. It can be hard to ask people to begin paying a mobility package when they are already paying for their own car, or another similar service. It is when introducing MaaS that governments need to properly scale its resources. Improving a service is not simply scaling it up, it is about scaling back what is being done poorly (Humanes, P., et al. 2019). Another opportunity for addressing inequality is not only on what government has control over, this can entail public private partnerships. A city, or even state, government can offer incentives to private mobility operators to serve disabled or lower income residents at an adjusted fare (Jittrapirom, P., et al. 2018). These incentives can also work like federal aid programs where trips to grocery stores, for those that are lower income, or to medical appointments, for the elderly population, could be reduced fare. Forces that make an equitable transportation system are things that the City of Austin plans to expand its role. To support transportation outside of a personal vehicle there needs to be the ability to do so, including infrastructure that fosters walking, bicycling, and public transit. These transportation networks need to work together

with increases in high-density, mixed-use, and mixed-income developments (Bell, J., Cohen, L., (2014).

LEARNING FROM EXISTING PLATFORMS

Several factors make MaaS highly challenging to implement, and this can be attributed to several factors including a lack of incentives, limited technology, and the challenges of coordinating so many players each that have their own interests and success in mind. Finland has made significant advancements in MaaS development, through policy changes and cooperation among stakeholders. Forum Virium Helsinki, is an innovation and research organization owned by the City of Helsinki, that has put forward many recommendations for implementing MaaS. Forum Virium Helsinki describes conditions necessary for deploying a MaaS platform, which are listed below.

1. Operators allowed access to all transport modes
2. Set rules such as data transfer and customer rights
3. Using incentives to cover areas of low-density or to jump-start service
4. Change the mindset of these organizations from service provider to enabler.

Other researchers put forward other conditions they viewed as essential elements necessary for successful MaaS deployment, which are listed below.

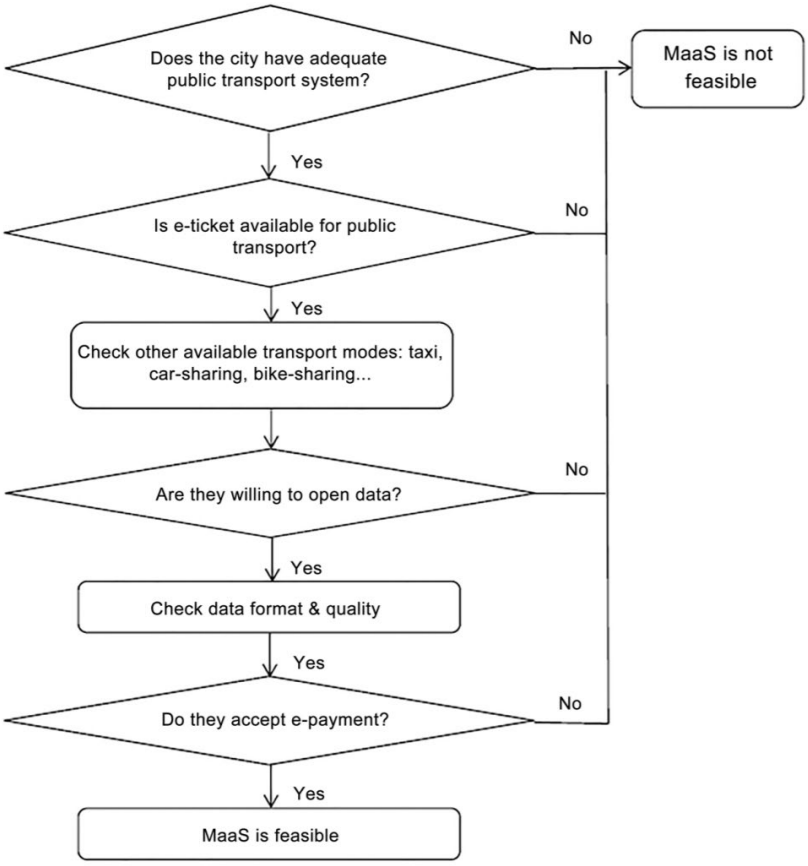

Figure 6: Ingredients for Successful Maas, Forum Virium Helsinki

1. Several transportation modes available
2. Much of mobility operators' data be open to a 3rd party
3. Most mobility operators allow 3rd party organizations to sell their services
4. Mobility operators offer electronic payment methods for their services.

This researcher offers a much more cut-and-dry mindset for the feasibility of MaaS within a community, as show in Figure 6 above. This image shows the overarching mechanisms within MaaS that must be present for the service to work at all. Even one of these pivotal services not being met could inhibit the deployment of MaaS. This researcher concludes

by warning of the possible dominance of few large players in MaaS, and that to prevent unfair competition proper policies must be implemented (Li, Y. and Voege T. 2017). Lastly, one final researcher proposes their set of essential elements for MaaS implementation, which are listed below.

1. Collaboration and trust between stakeholders
2. Standardization of data
3. Financial support from similar organizations
4. Business opportunities for potential actors
5. Appropriate infrastructure
6. Proper data security and privacy
7. Enabling technology and
8. Added value to users from MaaS service (Jittrapirom, P., et al. 2018).

These researchers vary minimally in their descriptions of necessary components required for successful MaaS Deployment, though a common theme emerged from all three. Requirements for data transfer and privacy was a recurring theme, as well as an established transit and mobility infrastructure, and the willingness to allow 3rd parties to have access to mobility services particularly in an online or mobile platform. Utilizing information gathered from each researcher, this PR establishes its own outline for necessary pieces for MaaS implementation, which will be used to understand readiness in Austin for a MaaS platform.

1. Several existing mobility opportunities
2. An environment friendly to mobility beyond personal vehicles

3. Specific achievable goals for MaaS for users and by providers
4. Live tracking on transit services, and the ability for electronic payment
5. Data transfer standardization
6. Mutual trust among project partners and by users
7. Mutual benefits between mobility providers

UNCERTAINTY IN MAAS SYSTEM ORGANIZATION

Though researchers have a concept carved out for the ingredients that are necessary for a functioning MaaS system, uncertainties in modeling, cooperation, and collaboration still exist. Forum Virium Helsinki proposes three likely possibilities for mobility markets to develop. The first being "Winner takes all" where there is one predominant organization and one service provider that covers the mobility needs for citizens. The second, "Public transportation takes all" where 3rd party services are not highly utilized and almost all trips are provided through public transit. Lastly, is the concept of "Roaming ecosystem" which is what many MaaS developers strive for. Roaming ecosystems include several mobility providers where users of these services are connected to all mobility options. The problem with our current transportation methodology is how siloed mobility providers are. Breaking down these silos includes slowly breaking down the barriers that exist, servicing multi-mobility to total management of these services under single platforms, then eventually guiding use towards this ideal of "roaming systems" (Hietanen, S., and Sahala, S. 2016). Within this light, breaking down these silos comes down to how willing different mobility

sectors are to work with each other, including public, private, and community stakeholders. A recurring concern by different mobility services is accommodating a single revenue stream and ensuring their share of profits are maintained. For a MaaS platform to function and be scale-able between cities these differing sectors must acknowledge these concerns head-on to work together (Humanes, P., et al. 2019).

UNCERTAINTIES IN USER HABITS

Another uncertainty to MaaS deployment is in modeling demand and supply of services. The rationale behind the difficulty in demand modeling is the extent to how dynamic and comprehensive mobility services and modern lifestyle are. There is substantial variability in ICT, responses to travel recommendation systems, other subjective considerations by users, and MaaS plays a role in all these activities, thus increasing challenges for modeling. Thus, approaching these concerns requires reflection on the theories and choice models to further understand travel behavior and decision-making processes of future users. Planning for MaaS also poses challenges for mobility providers, on the supply side. Particularly these concerns are focused on vehicle fleet optimization, this can be particularly challenging during peak flows of traffic when most users are using or entering a central business district. These concerns are particularly pertinent for micro mobility and car-sharing services that are not on fixed routes.

Some service providers suggest the opportunity for automated vehicle deployments in aiding this challenge, though AV's also pose a risk of increasing congestion through passenger-less trips (Jittrapirom, P., 2017). Further, uncertainties to the success of MaaS

implementation are the ability to shift users' mobility habits, this is particularly challenging for commuters accustomed to driving alone, or unfamiliar to public transportation. One last uncertainty with the deployment of MaaS is the need for accessibility for all users. MaaS must be designed with all users in mind, considering that some may not have access to a smart phone or the ability to reload an account online. This can be aided by cards that are able to be reloaded at local convenience stores (Goffman, E., 2020).

MaaS Barriers to Implementation

Beyond uncertainties with implementing MaaS there are existing barriers that need to be broken down including business model standards and contractual obligations. First, to implement MaaS a platform will need to exist where for each user there is just a single identity, this includes open data and payment methods despite using various service providers. Some mobility providers are not willing to allow these 3rd party payment methods, and thus are not able to be part of a MaaS platform (Li, Y. and Voege, T. 2017). Each mobility provider that does not allow this compatibility weakens the opportunity for successful service. Second, barriers exist by circumstance possibly outside of mobility operators' control. It is known that payment integration, as well as public transit services are two of the most fundamental aspects of MaaS, however, some public transit agencies

can be stuck in contracts with smart card operators. These contracts between transit providers and smart card operators can be as far as 10 years, posing a significant roadblock to implementing MaaS (Humanes, P., et al. 2019). One last barrier in implementing MaaS includes lack of necessary authority in integrating agencies. Public transit agencies may lack the necessary authority on their own, though in cooperation with other agencies like metropolitan planning agencies may provide the necessary assistance in establishing a functional MaaS integration (Goffman, E., 2020). Figure 7 above, displays VIA Metropolitan Transit's "GoMobile" phone app that allows for integrated mobility services through a partnership with Moovel, a private software company.

Figure 7. Public Transit Private Partnership. Source: VIA Metropolitan Transit

EMERGING OPPORTUNITIES

Considering various barriers and other challenges that are faced, organizations still work heavily to understand a possible common platform for the service. Masabi is an organization that works to develop mobile payment systems, frequently used in public transportation services around the world. Masabi is highly attuned to developments in MaaS and has noted three dominant approaches towards implementing this service. The first being a subscription-based method, seen as an easy substitute for corporate plans,

though these plans tend to favor wealthier individuals as they are more likely to be able to afford a large up-front cost. Another problem with subscription based platforms is that people often do not have set schedules and may not be able to fit just one "package", and lastly this method does not respond to supply and demand of transportation availability. The second common method utilized is Practical Maas, that includes the ability to access public transportation through other leading mobility applications. Practical MaaS does not require subscriptions, though may not establish a single platform that includes all mobility services. The last method is "Account-based MaaS" that utilizes a smart-card or mobile ticket of some sort where users are linked to one account and the fare is calculated real-time (Gooch, J. 2019). Clearly, several methods for MaaS are available though come with their own set of difficulties.

BARRIERS TO INFORMATION AND KNOWLEDGE EXCHANGE

Something that makes MaaS so difficult to implement is the difference between local, state, and even federal laws. Data privacy is one example of this, there is little federal guidance on how data is collected and used so it has come down to cities themselves that create their standards, which we are seeing as many cities have begun adopting MDS standards. This difference in standards creates some roadblocks when companies have legislation that is on a different scale. A challenge many cities, states, and even nations are facing is the struggle of keeping laws up to date with such rapidly changing technology. A

way to update laws quickly and easily is something that is important and a missing piece for MaaS deployment (Humanes, P., et al. 2019).

A challenge for implementing something like MaaS in the US is inherently difficult due to the siloed nature of our local, state, and national government structure. For MaaS to succeed people need to know that they have multiple choices, and multiple operators are needed rather than a single transportation agency running it all (Humanes, P., et al. 2019). It is for these reason that public and private agencies are needed to create a holistic vision for what MaaS can look like. Rather than only bringing in experts on infrastructure, transport, and planning, as is typically done, experts on other areas are needed. Specialists in aspects of data science and cybersecurity, as well as environmental and public health, are other parts of MaaS that need to be considered because this is a technology that requires so many bridges between agencies to function seamlessly. Keeping focus and a lens as of what daily users are going to look like and going to need is an important aspect of services that can be overlooked (Sianosian V., and Engblom S. January 2020). This is technology that most people are not familiar with, and requires a re-thinking of organizational structures and collaboration, it is for these reasons that fostering knowledge share is so important.

There are four common barriers to knowledge share, which are listed below.

1. Organizational
2. Workplace environment
3. Available resources
4. Political.

Organizational barriers include bureaucratic hurdles and silos that can inhibit vertical or horizontal collaboration. Depending on how open and collaborative the culture of a workplace can determine whether people will tend to keep information to themselves or be willing to work together. The resources available are another common barrier and is often due to the infrastructure or services available like space, available time, or internet communication abilities. The last common barrier is political, and this often comes down to workers that may hoard knowledge to retain or gain power for themselves. Many of the common barriers tie into each other as tacit knowledge generally depends on the willingness of employees to share, even if sufficient internet communication or organization exists (Pee L.G., and Kankanhalli A. 2016). Another aspect of the willingness for project members to work willingly and effectively is if what is being done is regarded as useful. This is regarding project evaluations which can be regarded as additional work, and thus wasted time. When evaluations are done in a way that foster reflection that results in learning within teams, participants are much more likely to be engaged and participate (Hartmann A., and Doree A. 2015). There are two types of knowledge, including tacit and explicit, effectively sharing both tacit and explicit knowledge is important in successful development of a project, though tacit knowledge is much more impacted by the barriers mentioned previously. Tacit knowledge is that which is formed from information, relationships, and experience that forms beliefs, perspectives and ideals. Explicit knowledge is much more straightforward, as knowledge that is objective and factual (Costa E., et al. 2016).

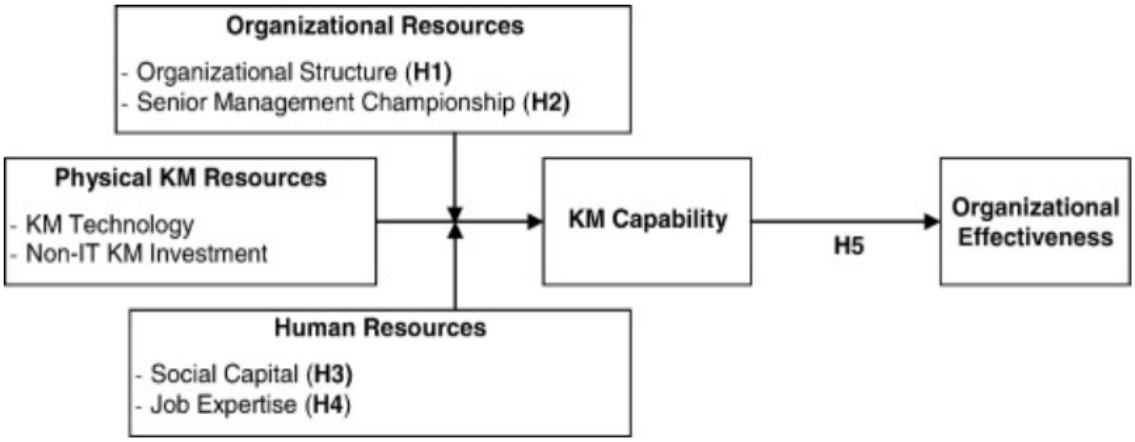

Figure 8. Depiction of Knowledge Share Process. Source: Pee, L.G. and Kankanhalli, 2016

Figure 8 above provides an easy to understand visual of all the aspects of knowledge share that are necessary for effective management. Like the four barriers mentioned previously, figure 8 represents the fine balance among organizational, physical, and human resources that must be present, though these can only be effective when managed properly. Opportunities for this open collaboration include incentives or rewards, where in addition to adequate technical support in place, partners will be more willing to put effort into breaking down barriers to work effectively (Pee, L.G. and Kankanhalli 2016). Further, it can be helpful for project organizers to look at existing projects, including organizational and knowledge management structure. It is important for partners to use the experiences they have had in similar projects and provide a space or time for reflection to understand how each of these experiences can be manifested in the context of this new project.

Reflection on prior projects and planning for the existing, needs to be done with a concrete goal in mind. It has been shown that when the goal is obscure, or the purpose is unclear, that a significant barrier to knowledge sharing exists as a result (Hartmann A., and Doree A. 2015). Many of these barriers and opportunities can come down to partners understanding what the stakeholders will want out of this project. Understanding the needs and expectations of the user can assist in guiding the goals for the project, narrow their scope to similar projects and to understand its' failures and successes. Through dialogue with stakeholders, governments and other partners are likely to have more up-to-date knowledge on issues, which can assist in continued update of laws and regulations with quickly advancing technology (Riege A. and Lindsay N. 2006).

The Shared Use Mobility Center (SUMC) is a research organization that provides guidance and observations regarding opportunities for advancing mobility opportunities. The SUMC released a brief regarding four actions for overtaking common barriers to mobility integration, such as MaaS. The four goals included establishing an integrated set of mobility goals and desired outcomes that increase access to options, break down silos, create new structure of innovation, and identify regulatory options and leverage.

In integrating mobility goals and outcomes, SUMC suggests stating specific goals and pathways to getting there. MaaS is a new platform, thus transportation agencies can use this time to redefine their mission from individual modes into connecting people to opportunities. These include "mode-agnostic goals" where every family has access to a certain need 15 minutes travel from their house, or all trips less than a mile can be done easily and enjoyably without a personal car. Additionally, forward-thinking tactics can aid

MaaS development like establishing a chief mobility officer within a city or require developers to incorporate impact of mode share in traffic impact studies. Collaborating among technology systems to synthesize any data collected to be used for proper short and long-term planning.

The second opportunity suggested by SUMC is breaking down silos, within transportation alone there are so many agencies and organizations, each with their own jurisdictions and regulatory structures. With so many stakeholders, alignment of goals and an understanding of the leverage and unique benefit each organization can bring, as well as any limitations, is a necessity. Opportunities for fostering this collaboration including forming cross-disciplinary teams to work on a specific challenge or issue. Another opportunity is to convene stakeholders, this can include public agencies, research groups, and industry professionals to find solutions through the collective resources each player can bring. One Last opportunity is to establish a coordinating strategy, where transportation stakeholders are brought together to achieve a goal.

The third opportunity for cross-agency collaboration is to create new structures for innovation. Because mobility is a developing topic this requires tech-literate staff to enable opportunities for bringing in or sharing knowledge, which is highly useful. Bringing in knowledge can include establishing an environment to attract talented workers, utilize university connections, or establishing specific roles to work with these services. This work can be done on multiple levels, from regional down to the specific city. One last opportunity the SUMC proposes is to identify regulatory options and leverage, particularly

within governmental ability to adjust policies to alter public spaces, taxes, and the ability for experimentation on city streets (Shared-Use Mobility Center).

Further research offers other suggestions for agencies looking to establish MaaS and taking into consideration, and tackling, the multiple levels of uncertainty that exist in its implementation. The first point is to be flexible and collaborative, as technology will continue to evolve no "standard" protocol for organization or regulation will continue to stay relevant. The next point echoes what was mentioned by the SUMC of using your infrastructure smarter, and to escape the "it's always been done this way mentality". An example of using infrastructure in a smarter way is to dedicate a lane used for parking instead for transit use and bicycling. The next opportunity proposed is to ensure MaaS is implemented in way that users are taken into consideration while balancing the interests of each project partner. Each business involved with MaaS is going to want their revenue as quick as possible, these interests need to be balanced with users who do not have access to a bank card or smart phone. The next point brought up is that while data is very important, not to forget that the users are who this entire platform was built for. This point acknowledges that even if a technology is so refined and catered to seamless and easy use, there will still need to be a shift in the understanding and acceptance by people of this technology into common use. Realizing what an organizations' own definition of MaaS is, who they are aiming to provide service for, and establish a plan of action based off this vision (Siranosian, V., Engblom S., 2020).

DYNAMIC ADAPTIVE POLICYMAKING AS AN ALTERNATIVE

Some researchers propose opportunities for adapting policies to meet the uncertainties posed by emerging technologies like MaaS. One opportunity is called "dynamic adaptive policymaking" (DAP), this policymaking and policy evaluation method is made up of four steps, that are displayed in Figure 9 below. Rather than waiting for information to become available, this method deals with the uncertainties right away. Because policy is one of the largest hurdles towards

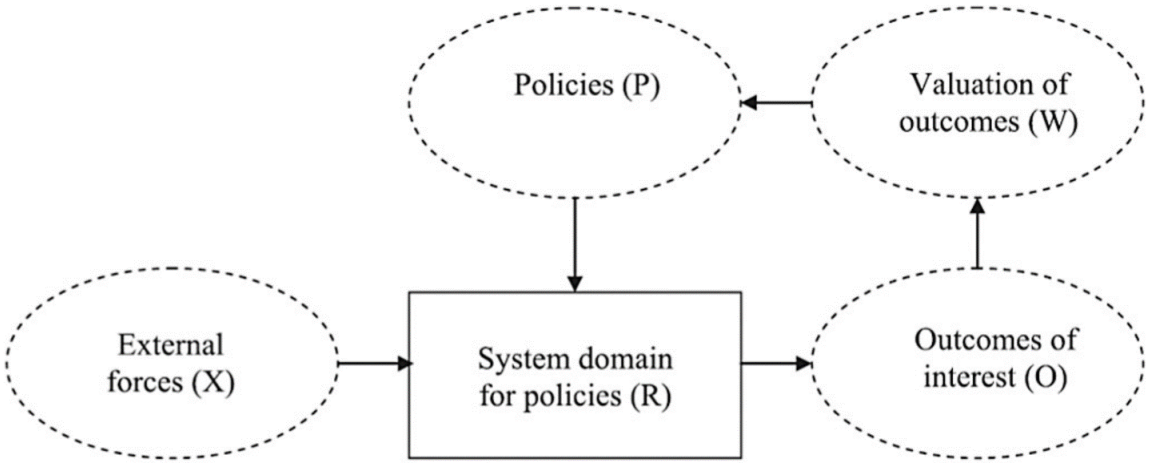

Figure 9. Dynamic Adaptive Policymaking model. (Jittrapirom, P., et al. 2018)

reaching necessary demands and incentives for MaaS to succeed, policy changes must begin at the public agency on the scope responsible for implementing the platform. DAP is a method for policymaking that Austin can consider when establishing a technology evolving as quickly as MaaS.

Taking into consideration the nuanced and complex nature of implementing a MaaS deployment, following is a list of the necessary action items informed by this PR that can aid successful deployment.

1. Established goals achievable by MaaS, set benchmarks, and set priority vision
2. Identify priority project champions and establish roles and benchmarks
3. Gathering important players and stakeholders
    a. Ensuring a collaborative space with open knowledge share
4. Learn from existing and proposed projects
5. Host public outreach events to inform and gather input
6. Continually match progress with benchmark goals

CONCLUSION

So much mobility infrastructure exists in Austin though most of it is not being used as efficiently as it could be. Researchers propose methods for achieving an operational MaaS system, including policy and infrastructural adjustments, to methods for information exchange between stakeholders. MaaS implementation faces challenges in modeling use, the siloed nature of mobility sectors, and the challenges in bridging knowledge gaps between agencies. Researchers propose methods for achieving production cooperation among agencies, including mode-agnostic mobility platforms, holding the user at the center of discussion, and alternative methods for policymaking. Being a new technology there will be a learning curve for most of the staff, and likely barriers to knowledge transfer will be even more heightened. Common barriers to knowledge share are organizational, workplace environment, resources available, and political. Understanding these barriers

and taking this time to work collaboratively and flexibly with other agencies and departments is more important than ever.

Chapter 3: MaaS Case Studies

There are several examples of MaaS exist in the US, this project evaluates VIA a mobile ticketing platform in San Antonio, TX, New York City's Late Shift Pilot program, and Whim App used by the City of Helsinki. Each of these programs is operating at a different level of deployment and each in unique contexts. These cases each highlight a different aspect of MaaS that are particularly helpful for understanding deployment in Austin.

CASE STUDY 1: VIA METROPOLITAN TRANSIT, SAN ANTONIO, TX

BACKGROUND

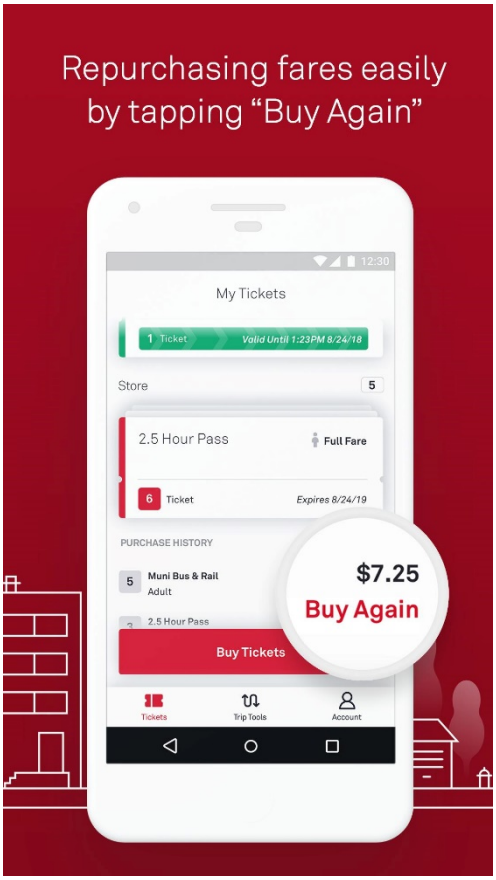

Figure 10: goMobile Screenshot. Source viainfo.net

VIA Metropolitan Transit, is the transportation provider for San Antonio that has broken the ground on several innovative technologies including a Wi-Fi-equipped bus fleet, and continues this innovation through the VIA goMobile smartphone app.

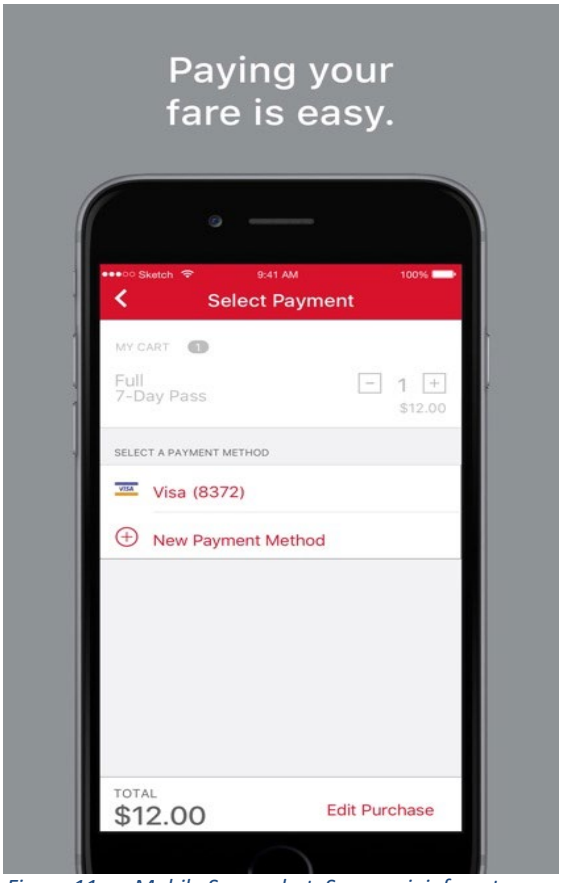

Figure 11: goMobile Screenshot. Source viainfo.net

VIA is a private transportation provider, that serves fourteen cities within the San Antonio metropolitan area as well as some unincorporated areas of Bexar County. Initially started as part of VIA Reimagined, an action plan by VIA that focuses on three aspects of improving mobility opportunity for its service. VIA Reimagined looks to create

1. A better bus system, with frequent and more reliable transit 2. Advanced rapid transit, through a network of high capacity vehicles that can include dedicated transit lanes, and 3. Smart transit, which utilizes technology and partnerships to improve the "VIA" experience for riders.

MAAS PLATFORM

VIA created the goMobile App, in partnership with Moovel, an organization that works with cities to create innovative solutions to mobility challenges. Shown in both figures 10 and 11 above, the goMobile App works to establish a simple platform for payment and trip planning among VIA transportation services. Using both card (Visa, Mastercard, etc.) and mobile payment methods (Google and Apple Pay) users are presented with several ticket choices to buy. Through Via goMobile, users are able to buy a day pass, 7-day pass, 31-day pass, 2.5-hour pass, as well as VIATrans disability services. For residents that do not have access to a smartphone, paper tickets can be purchased at retail outlets like HEB stores, or day passes are available for purchase on buses (VIA Metropolitan Transportation). This service improves both the trip planning aspect for transit, and also removes friction from boarding through reductions in cash transactions. VIA goMobile released an added feature for the app that allows users to see nearby mobility options, like B-Cycle stations, Lyft rides, and Zip Cars. Though payment for all these mobility options is not on a single platform, planning is made easier through the single goMobile service.

IMPLEMENTATION AND MANAGEMENT

In an interview with VIA, the agency was asked for any advice they had received to establish this project. VIA responded in this interview with ensuring that when working with their partner Moovel, that they were on the same page in terms of expectations and timelines for projects and met frequently to ensure these goals were maintained. Another question asked was if VIA had any advice for other cities looking to implement a similar technology. VIA responded with first looking for a problem that needs to be solved, that when solved will improve the lives of customers. They acknowledge that it is too easy for public agencies to be caught up in "shiny" or exciting projects that do not solve any real problems (Smart Cities Connect).

SYSTEM PERFORMANCE

While this does not meet the definition of MaaS posed in this paper, there are elements of VIAs goMobile platform that are compatible. GoMobile's service allows users to make all Bus ticketing purchases through the comfort of their own time and aided through trip planning services offered. By providing Available mobility services nearby, like B-Cycle and Zip Cars, people can organize their travel more simply and possible efficiently than before. VIA has made several investments into their services within the last few years including added buses and higher frequency routes. Results are mixed, after a continued trend of lowering VIA ridership from 2013 at over 44 million annual riders to

34 million riders in 2019, in line with national ridership trends. These numbers are on the rise again and have seen four consecutive quarters of ridership increase as of early 2020.

IMPLICATIONS FOR AUSTIN

Implementing MaaS in Austin can take several lessons from the course of implementation that was taken with VIA in San Antonio, beginning with the layout this project established as essential elements for MaaS deployment. VIA offers several transit opportunities, including bus transit, but also smaller scale ridership options for disability services as well. Additionally, many other mobility opportunities including B-Cycle, scooters, rideshares like Lyft and Uber, and car-sharing like Zip-Car.

Following, for a successful MaaS deployment there should exist an environment that is friendly to non-personal vehicle mobility. San Antonio is a very large city that is also known for its lower density sprawl. Despite this existing low-density development, several innovative initiatives are in the works to expand transportation services, including the three-part plan to expand VIA. Further, while there are some specific goals, the goal for "smart services" is not made much clearer. Live tracking is another necessary function, which goMobile does not offer. However, trip planning services are offered through goMobile through Google Maps, additionally by typing in a bus stop ID information for when the next bus will come is provided. Data sharing standards are also essential, however that information was not made available for research.

The last two essential elements include both mutual trust between services providers as well as mutual benefits, both of which are the case in this deal. VIA partnering

with Moovel allows VIA the advanced transportation services that are desired and Moovel both the publicity and revenues from VIA using their services. This partnership is not only a win-win for mobility providers, as they mentioned how well they work together in an interview, but also a win for users as they have a comprehensive and improved service.

Some of the highlights that Austin can learn from this case including the innovative spirit and far-reaching goals to improve VIAs transportation services in several areas. Another unique benefit here is to try and keep a good relationship with your stakeholders throughout the project to arrive at a best possible result, and lastly to ensure equity in development as VIA does here with disability services accommodated through goMobile, including reduced fare options, as well as paper tickets conveniently sold for users that do not have smart phones.

CASE STUDY 2: LATE SHIFT PILOT PROGRAM, NEW YORK CITY

BACKGROUND

The New York City Metropolitan Transportation Authority (MTA) is planning to begin what is call the "Late Shift Pilot Program", centering around improving mobility for late night and early morning transit riders. The MTA is planning ahead with this pilot, as late-shift employment, like healthcare and food services are expected to increase faster over the next five-ten years than the overall economy, which already encompasses 17% of New York City's workforce. The idea is that investments need to be made to cater to those employees working outside the traditional 9-5 and encourage this growing diversifying

economy. This pilot will create an extension of subway travel by connecting users to ride-share programs to get them to their destination.

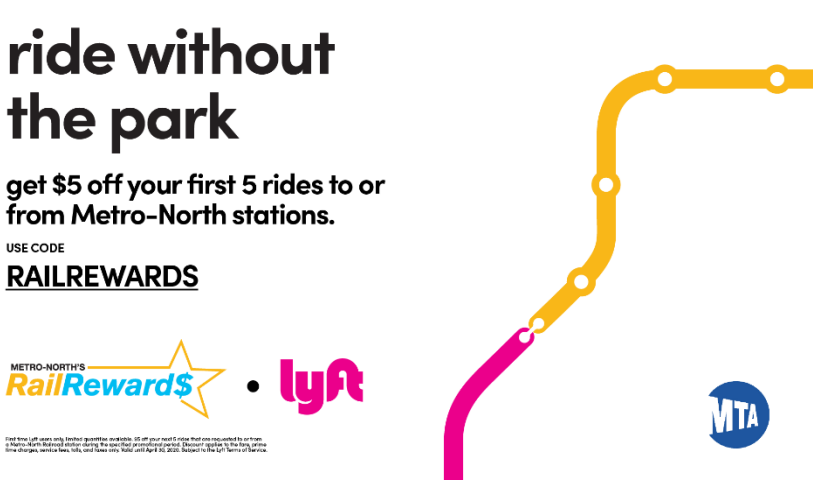

Figure 12. Lyft and MTA Collaboration. Source: MTA

This platform is tailored towards residents who live within the five boroughs, but in areas that are further than a half-mile from the nearest subway station or where bus services are less frequent than every 20 minutes. These are the residents that are more likely to face mobility limitations because of limited service around them, so advancing these mobility opportunities through one platform can complete this trip in the simplest and least expensive way. Figure 12 above illustrates previous collaborative efforts that MTA has made in collaboration with Lyft to subsidize multi-modal trips.

Implementation and Management

There are two phases for this project, 1. To look at data collection and analysis for structuring the pilot, which will conclude mid-February of 2020, 2. Establishing the location, timeframe, and business terms of the pilot. The MTA planned to select a late-shift partner at the end of March of 2020, however these plans were put on hold in response to the outbreak of COVID-19 (Metropolitan Transportation Authority). An interview with

Mark Dowd, Chief Innovation Officer at MTA provided information on many of the barriers and opportunity this pilot presents. Dowd brought to light some of the biggest challenges in establishing a MaaS system, including the lack of precedent for this technology. There is no standardized payment piece, though companies are trying to step into that sphere, though these are not always desirable as these companies take a cut of profits and are not always reliable.

The problem with coordinating public transit with ride-share companies is that in a way the transit organization is giving up data and possibly the entire journey to these companies. In other cities that have partnerships with rideshare companies the services aren't integrated, so users are still directed towards the Uber or Lyft app for payment and are much more likely to simply use that platform for the entirety of the journey instead. Ride-share companies like Uber and Lyft are beginning to model as a "walled garden" where so many services are offered though to access them users will need to have their app.

The other difficulty jumps back to knowledge share, and some of the reasons here are that public agencies may just not work well together. Dowd suggests several opportunities to evolve past these barriers though, first being that public agencies need to begin thinking of themselves as retail organizations rather than everything within the own interest of their department. Similar to the opportunities mentioned as opportunities for planners, public agencies need to take MaaS as an opportunity to rethink how transportation is conducted, and move the model into a mode agnostic mentality, where the overarching goal is simply to move the most people as equitably and efficiently as can be

done. Dowd acknowledged that ego is a very big part of MaaS deployment, and to get organizations collaborating and coordinating, there needs to be an internal mandate for getting tasks done. Therefore, a structured goal and procedure is vital for effective organization in MaaS implementation (Dowd, Mark. 2020).

IMPLICATIONS FOR AUSTIN

Several of the points brought up by Mark Dowd are both good lessons for Austin to take into consideration when expanding its MaaS presence, and points that directly align with many of the essential elements required for a successful deployment. What is encouraging is that Dowd also suggests pathways to crossing these hurdles as well. The first essential element is to provide several mobility opportunities, of which New York City does very well. There already exists a highly extensive transit network that runs 24/7, including bikeshare, and other rideshare options.

Dowd brings this next point up as a challenge that has hindered the development of the pilot, that there needs to be a mindset shift to planning as "mode agnostic" where not only cars are prioritized and to shift thinking towards all-mobility solutions. New York City already offers a well-used and comprehensive transit network as well as a burgeoning bicycle network. New York City is heading in the right direction, though an all-inclusive mobility mindset needs to be encouraged. Establishing specific goals that MaaS can achieve is the next essential element for successful deployment, this pilot program does include a baseline population that hopes MaaS can support. This pilot program is guided

towards the growing late shift population that lives outside the area of frequent transit service, thus providing a baseline for goal setting. Live tracking of transportation services is another essential element for MaaS, of which the MTA provides a similar service to San Antonio's VIA, that offers links as to when the next subway or bus is going to arrive, so information of this element is limited. Data standards are another element of MaaS deployment, of which is highlighted as a concern by Dowd, though primarily in terms of giving up data by MTA to these third-party companies, where it sounds like details were still being worked out.

This point ties nicely into the final two essential elements of both mutual trust among stakeholders, and also mutual benefits met between them. Dowd describes trust among mobility providers as a challenging point, at that a lot of it comes down to the ego these agencies hold. Trust is important for breaking down these egos and ensuring that each provider will benefit from this collaboration. Dowd acknowledges an important balance between MTA and private providers is to remain within the MTA app when hailing an Uber or Lyft ride because beyond that it is likely that a user would just end up using Uber or Lyft for the entirety of their journey otherwise. Trust needs to be in place for mobility companies that they are not going to lose service by this collaboration.

There are several points that Austin can pay attention to when planning for its own MaaS deployment. This case study shows that not all collaborations can be as seamless in collaboration between stakeholders as VIA was with Moovel, and that creating an atmosphere that fosters trust between stakeholders is important. Further, setting baseline collaboration standards or "internal mandate" across agencies in terms of strategies and

behaviors between stakeholders in advance to prevent stakeholder egos from getting in the way of accomplishing tasks.

CASE STUDY 3: WHIM APP, CITY OF HELSINKI

BACKGROUND

In response to a growing population, increasing congestion, and falling environmental quality, the City of Helsinki established an ambitious transportation plan set to create innovative and multi-modal solutions for mobility. Helsinki holds an urban population of 640,000 people, and a metro population of 1.5 million, and is expected to

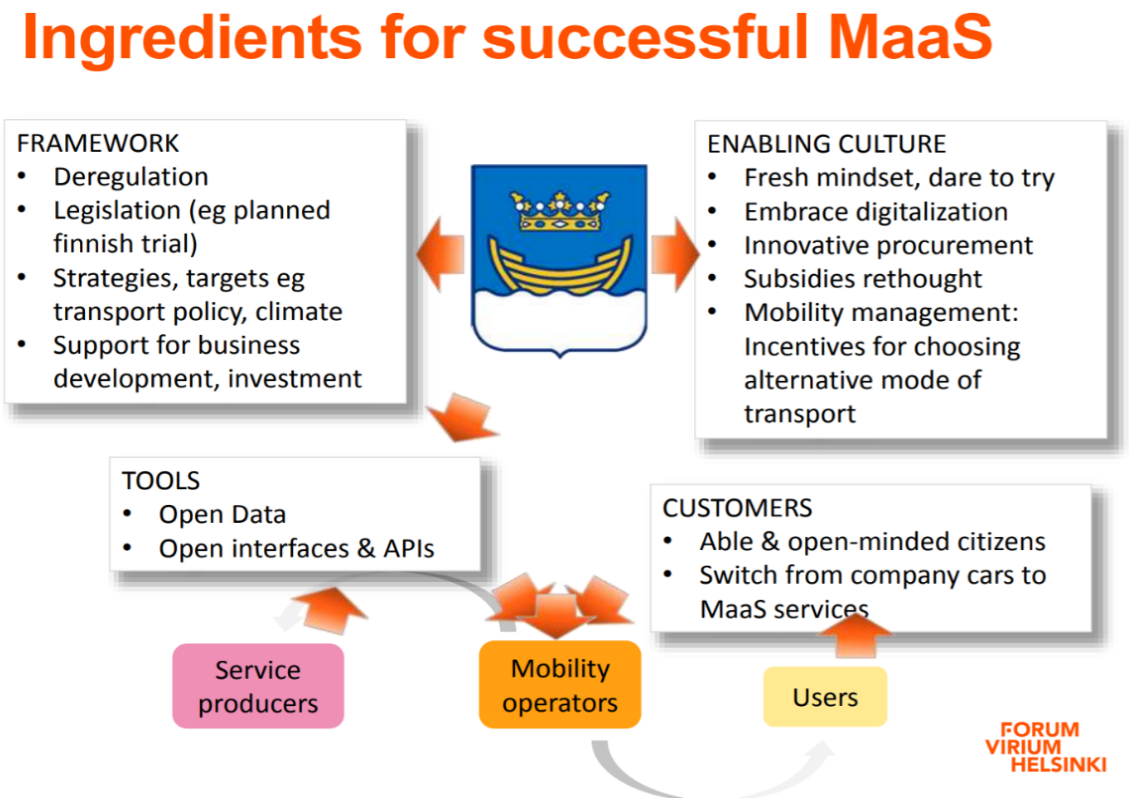

Figure 13: Ingredients for Successful Maas, Forum Virium Helsinki

grow by 40%

in the next 35 years. Helsinki also has plans to cut GHG emissions by 30% by 2030 and to be carbon neutral by 2050 (Helsinki Pioneers MaaS). It is with this increasing need for both efficient road use and reduced dependence on fossil fuels that Helsinki set out to establish an operating MaaS deployment in the city. Helsinki has been at the forefront of mobility innovation, including its Forum Virium Helsinki, which serves as an in innovative research organization that is owned by the city. Forum Virium Helsinki would conduct research and ultimately created a document that guided the city's policy recommendations to promote Maas deployment. This document supports all levels of stakeholders on the city, business, and user level. In Figure 13, seen above, Forum Virium Helsinki describes, in more depth, the ingredients that have been successful for implementing MaaS in Helsinki including alterations in government policies that led to the tools necessary for this implementation (Jittrapirom, P., 2017). As part of this innovative plan to transform mobility operation in Helsinki, the city partnered with MaaS Global, to create and deplay Whim App, which is widely considered one of the only truly operation MaaS deployments in the world. MaaS Global was founded in 2015 by a series of investors and first launched Whim in 2017 in Helsinki, which has now expanded to several cities across Europe (Sawers, Paul 2019).

MAAS PLATFORM

MaaS Global created the Whim App in Helsinki that offers transit, taxi, car rental, and bikeshare and scooter mobility options all available within the app. Figure 14 displays

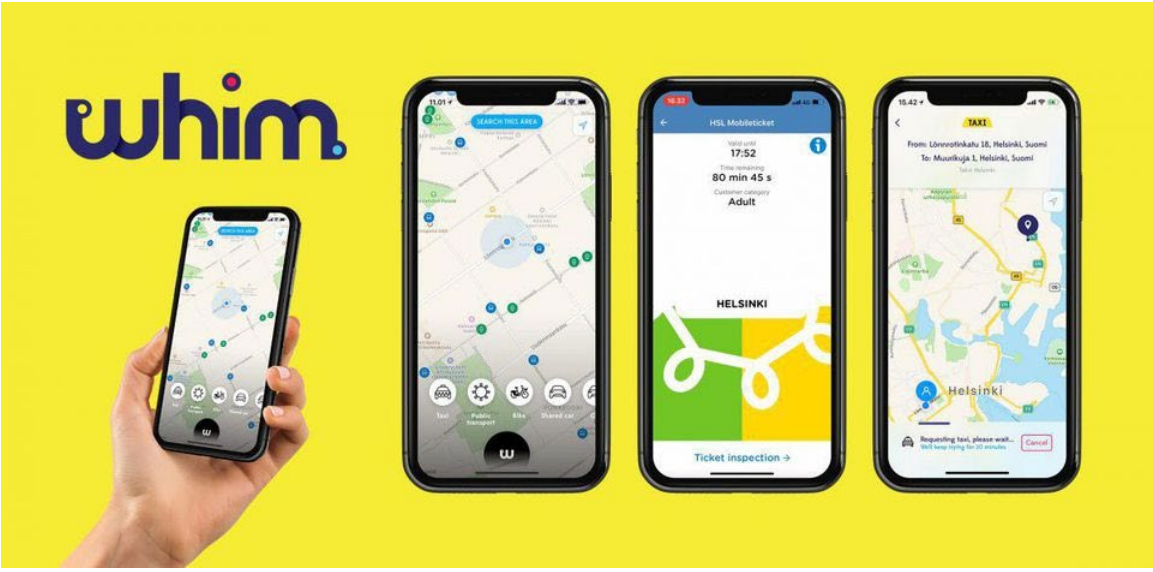

Figure 14. Whim App providing route planning and all available transport options. Source: Forbes

the user interface within Whim App, providing route planning services utilizing all available mobility services nearby. Whim can be both subscription based, including several mobility packages, or pay-as-you-go. Subscriptions include "Whim Urban 30" for €59/month that includes all mobility services that includes some limitations distance of time limitations on services, or "Whim Weekend" for €249/month, as well as "Whim Unlimited" for €499/month featuring unlimited car rentals and public transport tickets, 30 minutes city bike rides, and 80 taxi rides up to 5 km (Maas Global).

PERFORMANCE AND USER INFORMATION

Whim App has proven to be hugely successful after first launching in 2017 has achieved 1 million trips by June 2018, and only increased success thereafter, by achieving 2 million trips 4 months later in October, and 3 million trips 3 months later in January 2019. MaaS Global has received several awards for mobility solutions, design, and smart city

features with Whim (MaaS Global). After successful deployment of the service, research shows several takeaways to note. The first being that MaaS riders use public transit more than their counterparts at 63% versus 48%. In terms of multimodality, Whim riders take taxis with public transit service three times more often than their counterparts. Public transit makes up 95.2% of the modal share on Whim, followed by taxi services at 3.8%, and bikeshare at 1%, thus public transit is the backbone of the service. Lastly, because users were quick to adopt alternative transportations, like bikes and scooters, it has been found that new transportation solutions can replace about 38% of daily car trips (Ramboll 2019).

IMPLICATIONS FOR AUSTIN

When looking at the essential elements this paper builds out for a successful MaaS deployment, Whim App includes many of these features. First being the inclusion of several mobility opportunities, including public transit, taxi services, car rentals, bikeshare and scooters. Following, the city or region needs to be open and willing to multi-modality and mobility beyond just personal vehicles. Establishing Forum Virium Helsinki as well as planning documents driving smart solutions to mobility services is very progressive and displays momentum towards new solutions. The third element is to have specific goals that MaaS can establish, while thorough research on this topic was not available, Helsinki clearly had figures in terms of existing environmental, traffic, and population figures, and

had benchmarks for the future. The following element is live tracking of services, which is a feature on Whim.

Following data sharing agreements are part of a necessary Maas Platform. Whim does collect information on personal details and verification information, like place of residence and if a user is licensed to drive. When using the service, the App will collect transaction, positioning and location, travel, calendar, and other like data. Third parties have access to personal data as well.

Lastly, essential elements include mutual trust and mutual benefits between mobility providers as well as users. There did seem to be a positive relationship at play in this deployment as both the City of Helsinki as well as MaaS Global are poised to succeed from this collaboration. The City of Helsinki is able to gain the "smart city" solutions that it was driving to have in its strategic mobility plan, and MaaS Global was able to have direct market for their service, as well as notoriety as being one of the first successful MaaS deployments in the world.

A takeaway that a deployment in Austin could benefit from the Helsinki case study is utilizing the community research potential in the area, as well as the "smart" solutions organizations that reside in the Austin area. Forum Virium Helsinki provided recommendations for policy and structural changes that can be made to foster MaaS deployment, Austin can utilize the research being done at the University of Texas to assist here.

CONCLUSION

These case studies emphasize the importance of many concepts noted previously, including the need for up-to-date transit information like tracking and delay updates, the overarching goal of developing this project for the users, and the importance of working cooperatively and effectively across departments and agencies. Without up-to-date information, VIA's goMobile would not be able to provide a reliable trip planning service and would turn people away from the possibility of seamless mobility transfers. The New York City Pilot Project highlights the need for stakeholder trust, and the need for cooperation to allow a best product for the user. Lastly, Helsinki displays the achievements that can be made when there is holistic support for smart mobility solutions at all levels. At the core of each of these case studies is the user, and these platforms need to be developed with actual needs in mind for the betterment of resident's lives. Without a proper challenge to achieve or problem to solve, there will be no goal to work towards in establishing this technology and will ultimately be unsuccessful. Lastly, it is vital for departments and agencies to work cooperatively on achieving these projects, with so many aspects that need to be tied together to function properly and seamlessly, one organization cannot be made to be more superior or inferior than any others.

Chapter 4: Challenges and Opportunities for Austin

Austin is served by several separate mobility options, while this is promising it creates additional need for productive collaboration among mobility providers. Echoed by many researchers is the need for a comprehensive mobility network in tandem with an agreed-upon set of data-sharing standards, both of which Austin is well positioned for. This chapter looks to break down these concerns from a high level and offer input on methods for public agencies to foster an environment able to sustain a MaaS platform that should be considered when planning for MaaS in Austin. Austin is served by several modes of transportation, each of which can be utilized for different purposes. Hosting a diverse set of mobility opportunities is beneficial for not only allowing residents a mode choice other than their personal vehicle, but also for encouraging competition among services to ensure affordable options exist. Though, this benefit is only brought out when these services can be coordinated to function seamlessly between modes. Below is a quick view of some of the many mobility services provided within Austin, this chapter will provide further context on the mobility services and trends present within Austin and other major cities within Texas.

Table 1, shown below, displays just some of the several mobility options available within just the Austin. Each of these services uses their own system for rental, planning, and payments, these are on multiple platforms as well including phone apps, online websites, or even in person booking.

Table 1: Existing Transportation Services in Austin

Mobility Services in Austin		
Service Type	**Description**	**Agency**
Car Rental	Personal or by organization, renting cars from companies ranging from short term of a few hours, up to several weeks	Enterprise, Avis, Budget Car Rental
Car-Share	Vehicles are able to be rented on demand on an hourly or even daily basis, via app or online request.	Zip-Car, Car2go, Ubiquitous Driver
Transportation Network Company (Ride-share)	Typically over phone app, a driver is connected to passengers to provide short distance car rides are requested on demand (TX Dept. of Licensing and Regulation).	Uber, Lyft, Ride Austin
Dockless and Micromobility	Smaller scale mobility options that can be docked in stations placed around cities or dockless. These are typically fully or partially human-powered (NACTO, 2018).	Bike: B-Cycle, Jump Scooter: Jump, Lyft, Spin, Revel
Public Transportation	Mobility systems that are available to the general public that run at a scheduled time and may require a fare. These services can include buses, light rail, and subways (CDC).	Cap Metro – Buses, commuter rail

Krista Huhtala-Jenks, of MaaS Global, describes “Every time you ask a person to add another piece of information, one more detail, they will drop off. People want simplicity” (Humanes, P., et al. 2019). With this in mind, with so many services and so many platforms to move within Austin it is clear why many people would choose a personal vehicle as

there will be no information to fill, fixed routes to learn, or another app to download. Thus, MaaS can offer Austin a solution so these various mobility options can work seamlessly and serve as a viable alternative to travel by personal vehicle.

EXISTING TRAVEL TRENDS IN AUSTIN

In Table 2 below, the commuter trends, of workers 16 years and older, with the City of Austin are compared with other major cities in Texas experiencing a similar growth rate. Broken down between various mobility services Austin's reliance on personal vehicles is slightly lower, though also is the rate of public transit. The limitations by public transit users in Austin are made up for with a higher rate of commuters walking and, more significantly, biking (US Census Bureau). This information presents evidence that Austin may be in a better or worse position than other major Texas cities. Austinites are more willing to drop their personal vehicle, though comparatively fewer people are utilizing existing public transit services, which is said to be the backbone of MaaS.

Table 2: Mobility Trends in Major Texas Metros. Source: US Census Bureau

Commute Method (%) by Workers 16 Years and Older			
	Austin	Houston	Dallas
Drove Alone	75.4	78.1	76.7
Carpool	8.0	10.0	11.1
Public Transit	3.2	3.8	3.8
Walk	2.6	1.5	1.9
Bike	1.4	0.6	0.2

Taxi/Motorcycle	0.9	2.2	1.2

Austin encompasses several mobility services, each of which can prove to be a double-edged sword. These multiple services provide the mobility infrastructure necessary to host a MaaS service, though without any cross-over functionality between these services, none of these services are being used to maximize their potential. This variety of mobility options does align with the goals set out by the city in their various master plans to supply the pieces that encourage travel apart from personal vehicles. All these mobility pieces come with some challenges and considerations however, including proper data handling and privacy practices. Once these pieces function together, Austin is set in a better position than other cities in terms of alternative travel modes apart from personal vehicles, maximizing the existing mobility supply.

INFRASTRUCTURE FOR MULTIMODAL SERVICES

The City of Austin is making significant strides in enhancing its mobility network through various plans and investments being made. In 2016, Austin residents voted to pass a mobility bond that would utilize $720 million in bonds for improvements in transportation and mobility through the year 2024. In terms of mobility, the projects from this bond include sidewalk improvements, enhanced safety at intersections, and bikeway expansions (Austin Capital Projects). Other plans the city has put forward complement efforts made by the Mobility Plan, such as the Austin Bicycle Plan, Sidewalk Master Plan, or the Austin Strategic Mobility Plan (ASMP) (City of Austin Master Plans). Particularly

Figure 15. Bikeshare in Austin along protected infrastructure. Source: Streetsblog USA

important, in terms of establishing a framework for MaaS development in the city is by looking at the goals and strategies set forth in this ASMP. Some of the overarching goals of this plan are to reduce commuter delay, increase travel choices, and to set the stage for improvements in health and safety, affordability, sustainability, and innovation. By 2039 the Plan aims to reach a "50/50 mode share" where substantial reductions are made in commuters using personal vehicles to 50% and the other 50% utilizing alternative and active modes of travel. The plan aims to make significant investments in public transportation through high-capacity vehicles as well as increases in dedicated transit lanes. Managing congestion is to be done though transportation demand management (TDM), methods to efficiently utilize

Figure 16. Sidewalk network in Austin needing repair. Source: towers.net

capacity as opposed to adding costly infrastructure. One other policy approach considered in this plan is to "right-size" and manage the parking supply and use curb space efficiently. Lastly, this plan makes specific aims at developing shared mobility options by utilizing proper data management as well as emerging technologies.

These goals and strategies set the stage for a successful implementation of a MaaS platform in Austin, though it is through specific benchmarks and indicators that ensure these practices are met. Targets set forward in this plan are encouraging in seeing these goals through, including increased access within ½ mile of transit network, decrease the amount of parking spaces per capita, and promoting seamless transfers between transportation modes and systems (Austin City Council).

DATA AS A CRITICAL FOUNDATIONAL ELEMENT

Austin is one of the cities that has adopted a portion of the MDS platform for data sharing between mobility providers, such as scooters and bike-share, and the city. The data collected includes the device, whether it be scooter or bicycle, the duration and distance, beginning and ending census tract, and the start and end time. This information is available on the City of Austin website as a tool for transportation planners, community leaders, or policymakers to make positive changes in their communities. All information is stripped of identification and is posted 24 hours after the ride was taken, to maintain safety and anonymity of the user. Mentioned in various master plans the city has adopted includes the goal of increasing ridership on public transit as well as other methods like bicycling and walking. It is important for the city to be making these goals as MaaS cannot be successful

without reliable and comprehensive mobility alternatives to personal vehicles, but also riders that are willing to use these services.

DYNAMIC ADAPTIVE POLICYMAKING AS AN ALTERNATIVE

Dynamic Adaptive Policymaking (Reference Image 3 Above), was a concept mentioed earlier in this PR, as an alternative for establishing policies for a quickly evolving platform, shown in Figure 6 above. Within Austin, the sytem domain for policies surrounding MaaS would be likely through the City of Austin, or through the metropolitan planning organization in coordination with included cities, such as Austin, Pflugerville, Round Rock, Buda, etc. Centered around the metropolitan mobility network, portion (R) would unite all main players in MaaS development. Main players in this development would likely include the users, the transport mechanisms like personal vehicles, bike-share, and TNCs, and another main player would be the infrastructure like roads, unit parking, and rail. By taking all these players' interests into consideration the plan arrives at (O) the intended outcomes of this project. Within Austin, these interests would likely surround accessibility to the urban core and other major hubs, congestion relief, reductions in personal vehicle dependence, or diversification of economic drivers.

Once these interests are compiled, the format continues into (W) where policymakers will add a "weighting" or level of importance to each factor. In the case of the City of Austin, these weights will likely stem from the goals posed in the various master plans the city has adopted. Lastly, (P) the policymaker will establish the policies from

information compiled in each prior step, and evaluate whether these policies will resolve the percieved problem. There are two points for information collection for policymakers, including (P) evaluation of policies in place, and (X) the external forces. In Austin, external forces will likely be population growth, increasing roadway congestion, reduced air quality, and dealing with advanced technology like scooters on the roadway from agglomeration of Austin's tech sector.

The researcher puts forward steps to planning this adaptive policy method in five points. The first and second points are similar to common policymaking methods of identifying objectives and creating a roadmap for establishing policies, then identifying specific policies to apply. The DAP model enhances this planning standard in three additionaly steps. These additional steps begin with improving the robustness of these policies through identifying any possible strenths and weaknesses, and shaping this policy to reduce these weaknesses. The next step is to establish a dynamic monitoring and evaluation system where if reached will dictate actions to ensure the policy continues as planned. Lastly, building off the previous point is to prepare specific actions to be taken if evaluation measures reach a certain level. These actions can be to preserve, adjust, and capitalize on a policy, or a reassesssment to revise the policy entirely (Jittrapirom, P., et al. 2018).

CONCLUSION

Deployment of MaaS requires substantial planning and coordination among stakeholders across the board to implement. When implementing MaaS, more likely than not, a shake-up from the continued “it’s always been done this way” model will need to take place. Public agencies are most importantly going to need to begin by setting their goals and visions for implementing MaaS, to create a framework for arriving there. Following, public agencies will need to realize what MaaS is going to look like in their community, no standard exists, so understanding what this deployment is going to look like is vital. It is then important for a city to realize that simply having a platform to ease mobility will not be enough, and that policies must be made to not only make driving more inconventient but all mobility opportunities expanded and encouraged.

Chapter 5: Opportunities for Implementation in Austin

MaaS has the potential to solve many problems that a city aims to achieve, including congestion relief, air quality goals, and even health goals. Many of the benefits of MaaS align with stated goals for the City of Austin, in multiple master plans adopted. This PR set out to evaluate whether a single platform that includes all available mobility options within a municipality that a user can use for payment and trip planning, is able to be developed within the City of Austin, and what can be done to encourage its advancement.

MaaS Viability in Austin

This report built out a framework, based on several sources, of agreed upon essential elements that are necessary for a successful Maas Deployment, that is listed below

1. Several existing mobility opportunities
2. An environment friendly to mobility beyond personal vehicles
3. Specific achievable goals for MaaS for users and by providers
4. Live tracking on transit services, and the ability for electronic payment
5. Data transfer standardization
6. Mutual trust among project partners and by users
7. Mutual benefits between mobility providers

Building a decision from this structure Austin is in a very good position for moving forward. The first piece includes several mobility options for users to choose from. As a city lauded as a technology hub, many emerging and groundbreaking technology services launch or test in Austin, as is the case with several bike and scooter share services. Austin is served by more than five scooter and bikeshare companies, in addition to a robust transit system, among other services including the Red Line rail service show in Figure 17 above. The problem being that all these services are not utilized to their potential, and almost all require separate platforms for use. An established MaaS platform has the potential to utilize this mobility capacity more efficiently through drawing personal vehicle users towards these services

Figure 17. Red Line Rail in Austin. Source: Austin Monitor

Figure 18. Micromobility in Austin. Source: Curbed Austin

The second piece that this PR notes as a piece necessary for MaaS deployment is an environment friendly to mobility beyond that of personal vehicles. Experts argue that in addition to users needing choices in their mobility opportunities, the infrastructure to use these pieces is vital. The Austin Mobility Bond is a substantial opportunity for successful MaaS implementation, as this can ensure a comprehensive multi-modal connectivity across the whole city. In addition to the Mobility Bond, Austin also intends to establish an urban fabric oriented more towards non personal vehicle and multimodal methods through the Imagine Austin comprehensive plan. Austin is steering away from the "It's always been done this way" mentality, by directing policy and infrastructural development towards these multimodal developments. This is taking for on many streets in Austin, shown in Figure 19 above, where road space is reprioritized for non-motorized travel. This mentality is already present in Austin, as fewer people drive alone as compared to other major Texas cities, and also walk and bike at a higher rate.

Figure 19. Bike friendly roadways in Austin. Source: AustinTexas.gov

The next necessary piece that is set forth in this PR is to include a specific set of goals that MaaS can achieve. Creating these goals has two parts that are unique to Austin,

including an understanding of its user, where and when people are traveling, and the price they are willing to pay for this service, and the other part of goal in defining how the agency wants people to move. When creating a MaaS system, organizers have the power to shift more than just mobility practices to guide habits to meet city goals. These goals can include encouraging or incentivizing environmentally friendly modes of travel off peak-demand, by guiding users towards bike-share for example. Therefore, the City of Austin can help define how people move, and more closely align these methods to meet the goals laid out. Austin fosters this goalsetting by the existing division of Smart Mobility, it is these mode-agnostic sectors that can establish mobility plans beyond personal vehicle-oriented planning.

The fourth piece that is laid out in this PR for MaaS implementation is to include live tracking of transit and electronic payment. The Cap Metro phone application already

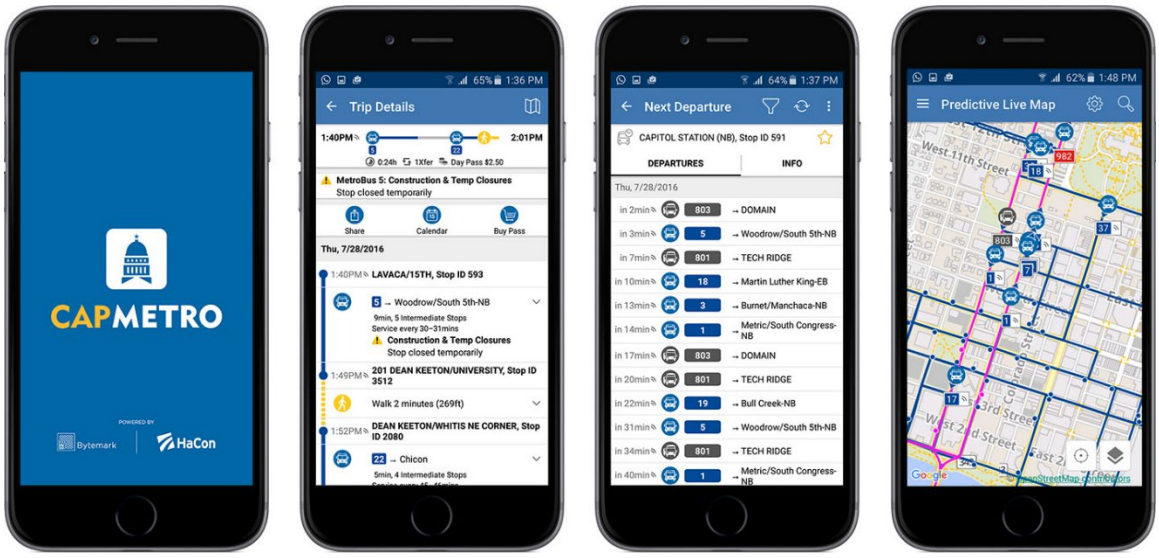

Figure 20. Trip planning, payment, and live transit tracking on Cap Metro App. Source: Smart Trips Austin

offers planning and payment of all Cap Metro services, through the 3rd party organizations

Bytemark and HaCon, and includes live tracking for many of its buses and rail service. These services are depicted in Figure 20 above within the Cap Metro app.

The fifth piece for implementation is standardized plans for data transfer, of which Austin is already taking a stance on by adopting partial MDS, is data standards. Austin taking part in adopting MDS data standards is already a big step in the right direction, as limited guidance by the federal government has left many cities to establish regulations for themselves. This overcomes the hurdle of MaaS that requires each user to have a single identity, and allows third parties access to MaaS platforms.

The sixth piece for implementation is mutual trust among partners, and this ties in with the final piece, number seven, which is mutual benefits between mobility providers. All these organizations need to be able to trust that they are getting a fair deal and have faith in their co-working mobility operators if they are willing to exchange data and potentially give up some market share. All mobility operators need to benefit from this MaaS platform, which can enhance trust among mobility providers. Therefore, when looking at the several policy, developmental, and infrastructural pieces that many experts consider pertinent for the deployment of MaaS, the City of Austin has placed itself in a good position for such successful deployment.

STEPS FOR IMPLEMENTATION WITHIN AUSTIN

Utilizing several research sources this report compiled common agreed upon action items that make for successful management and operations of a MaaS platform, listed below.

1. Established goals achievable by MaaS, set benchmarks, and set priority vision
2. Identify priority project champions and establish roles and benchmarks
3. Gathering important players and stakeholders
    a. Ensuring a collaborative space with open knowledge share
4. Learn from existing and proposed projects
5. Host public outreach events to inform and gather input
6. Continually match progress with benchmark goals

Figure 21 below provides a set of possible frameworks to pursue deployment of MaaS in Austin utilizing the 6-step action plan listed above.

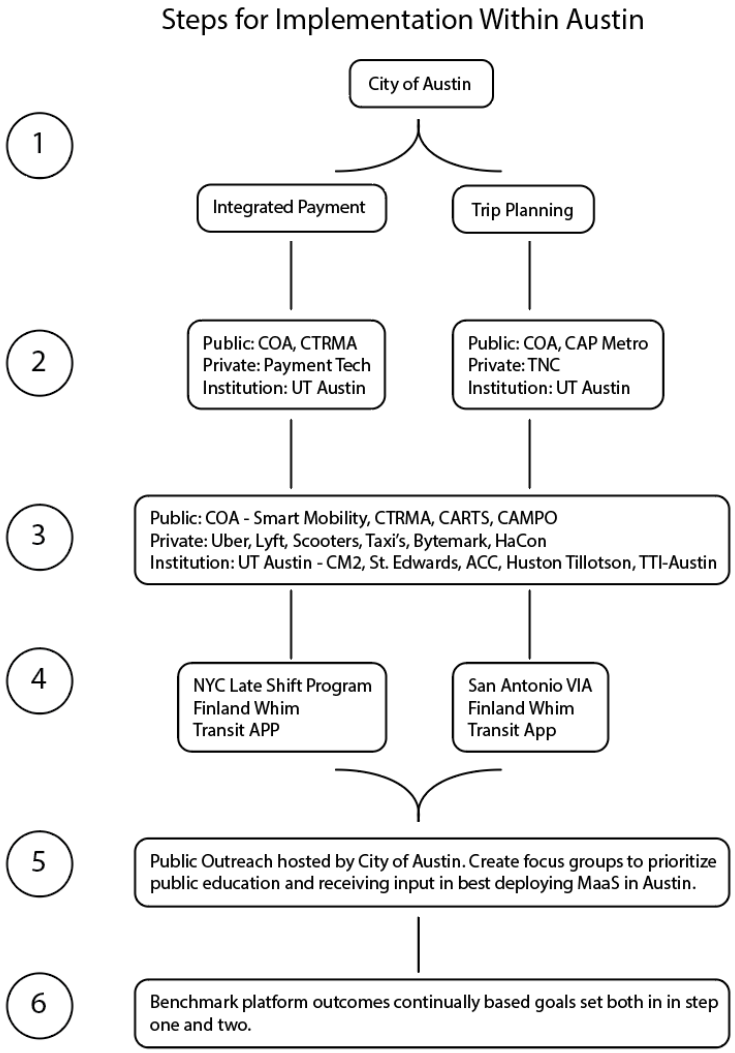

Figure 21: Steps for Implementation Within Austin

In this PR, the City of Austin (COA) is intended to initiate the effort to establish MaaS within Austin because of the ability to build on existing mobility efforts and the position of power the city stands that allows for successful deployment. As Austin is launching this effort, the first step is for the city to establish goals that are achievable by MaaS and the benchmarks to guide this implementation. The City must evaluate its current approach that it is taking for mobility within the city and understanding where the gaps in service exist (Zipper, D. 2019). This step has largely been accomplished already through several progressive measures COA proposed among its many comprehensive plans to promote multi-modal connectivity, and utilize equitable, sustainable, and affordable policies to do so. It is at this stage that COA should establish the broad goals it aims to accomplish through MaaS that will set the stage for conversation

to be held with stakeholders in following steps. These overarching goals will likely include reducing vehicular travel, improve congestion on roadways, improve air quality, and offer opportunities for healthy and active modes of travel. These are the goals the City will use to guide the development of its' MaaS framework. When creating the general structure, it is at this stage COA will establish its vision for implementation by prioritizing a focus of development, this report proposes two scenarios, including a focus on integrated payment and a focus on trip planning. Whichever development structure COA decides is more in-line with the goals they have for MaaS deployment is the platform that will be used in further steps.

Mobility challenges are often disproportionately felt by lower-income members of society, those that typically have fewer transportation alternatives. Thus, ensuring equity is a maintained goal is pivotal, this can include lower cost mobility bundles, or reduced fare to grocery and medical trips for lower-income residents. VIA GoMobile offers reduced fare trips and specific disability vehicles for use. Part of the goal-setting process is understanding who the users of this service are as well. It is important to ensure it is accessible for all as well. Part of goal-setting could include ensuring paper tickets can be sold within a certain distance of stations, or alternative mobility services are equipped with handicapped accessibility.

The second step is to find project champions and establish agreed upon goals and roles for each agency, this will be orchestrated by COA to find priority partners in the public, private, and institutional realm in the Austin area. A fine balance between public, private, and institutional agencies is essential as there needs to be a regulatory structure to

ensure that this platform model remains equitable for all users without one primary power. Without a regulatory role, or the understanding that MaaS is a service for mobility, the platform will run as a business where people are pushed to the highest price. Thus, whether a MaaS platform is developed as a public private partnership or solely as a public agency, there needs to be a framework in place for ensuring an equitable structure for all (Humanes, P., 2019). These project champions will serve as a leadership council that will represent the interests of stakeholders throughout project planning. Based on vision determined in the first step will define who this leadership council is composed of.

In the first scenario, where COA focuses their vision around a platform of integrated payment, the leadership council will include COA and the Central Texas Regional Mobility Authority (CTRMA) to represent as public agencies, and a member from payment technologies to serve as private industry representation, and lastly a representative from UT Austin to serve as institutional leadership and a neutral research position. Within this scenario, COA would serve in an organizational and regulatory role. COA would work to ensure the interests of users and equitable discussion is central to discussion and encouraged in plan preparation. CTRMA is the agency responsible for roadway toll collection in the Austin area, as depicted in Figure 22, and this representation would serve a financial role. As a quasi-governmental

Figure 22. Toll Roads covered by CTRMA within Austin. Source: Austin Monitor

agency, CTRMA would bring experience on financing with a government agency. Following, representation from the private industry by payment technologies would serve both a financial and organizational role. These tech agencies would provide guidance in integrating services to a common payment platform. Lastly, representation from UT Austin as an institutional and research role would offer guidance on potential best practices for deploying a MaaS platform in this context, and serve as an informed neutral party to balance regulatory and business interests.

It is at this stage where each project champions will propose and negotiate a set of achievable goals that they would like to see as part of this collaboration. With COA, this could include specific policies like decreasing the amount of parking spaces per capita, promoting seamless transfers between transportation modes and systems, and increasing the percent of city mobility datasets that are open and accessible to the public. CTRMA may promote integration with their tollways for mobility services. Payment technologies, may propose use of their technology as part of the developing MaaS platform. Lastly, UT Austin may require research funding and credit as a project partner.

If the COA were to center their MaaS platform around trip planning, scenario two, different champions may be chosen to represent the leadership council, and will likely have differing roles and expected outcomes. The COA will again be a representing agency that promotes equity and protects user interests. As a quasi-governmental agency, Capital Metro (Cap Metro) could serve as a representative as a public agency that will provide insight of both organizational and financial experience. Cap Metro will utilize its experience through operating the Cap Metro App that provides trip planning services.

Representation from the private sector can include transportation network companies (TNCs) that can assist in technical organization of a MaaS platform. TNCs already include qualities of a MaaS platform, where a driver is assigned a rider and the route is planned for that trip. Utilizing this experience in trip planning and building upon it will be highly beneficial to establish a comprehensive MaaS platform. Lastly, UT Austin could serve as an institutional and research agency to provide best practice recommendations in a neutral manner. Similar to the first scenario, these representatives will promote and negotiate goals and objectives they would like to see as part of this collaboration.

The third step of this framework is to gather important players and stakeholders involved in deploying this platform. Once the primary project champions are identified and agreed upon project goals are set, further stakeholders can be identified and included in project planning. Many of the stakeholders will likely overlap regardless of the priority scenario chosen. In addition to the COA, CTRMA, and Cap Metro, public agency representation could include a wide range of planning and transportation organizations within the Austin Metro. These could include the Capital Area Rural Transportation System (CARTS) that services counties surrounding and including the Austin Metro. CARTS is already integrated with Cap Metro services so further collaboration could bring an increasingly integrated transit system. Capital Area Metropolitan Planning Organization (CAMPO) is another important regional public agency to include in MaaS planning as it deals with planning and the transportation network for the Austin Metro. Because public transit is an integral piece of MaaS, all communities that offer Cap Metro service should be a stakeholder of this platform, that could include Round Rock and Leander. Following,

private agencies that may be included in collaboration include existing TNCs that operate in Austin, including Uber, Lyft, and scooter companies. These organizations have experience of operating in Austin and can provide input on user experience with said platform. Taxi companies in Austin are also important to include as they make up a share of the mobility resources and network within the city. Other private organizations could include payment technology companies that have worked with Austin before, including Bytemark and HaCon that work with the payment system for the Cap Metro App. There are several institutions within Austin that are assets to the city in terms of research, but are also helpful in collaboration as they serve as destinations for many people. The UT Austin CM2 office, St. Edwards, Austin Community College, Huston Tillotson and the Texas A&M Transportation Institute of Austin are institutions that all serve as destinations. Collaboration with these institutions can establish best transit and mobility opportunity around these popular institutions within Austin.

Because MaaS is such a wide-reaching platform that includes so many operators, planning in a holistic manner and bringing in all possible players is vital. Difficulties can arise when partnering between so many sectors and so many industries, including speed of administrative decision-making and scope of visions and approaches. There are opportunities from all sides to work to accommodate this dynamic.

Once these stakeholders are organized it is important to create an environment welcoming to collaboration and knowledge sharing. Noting the barriers to knowledge share previously, including organizational, workplace environment, available resources, and political, the project champions must take specific actions to prevent these. This will

include gathering all stakeholders in a neutral setting and placing stakeholders on a level playing field, including those who can assist aiding the conversation between industry jargon, which may be institutional agencies like UT Austin or other mediators. Here the project champions will portray collaborative stakeholder goals that the platform aims to achieve through MaaS deployment. As business interests are going to differ from those from public agencies, and all users must benefiting from this agreement, it is important to host effective knowledge exchange. Fostering information exchange can be promoted through incentives or rewards, by looking at existing projects that utilize a similar dynamic and offering time and space for reflection and discussion on these goals is vital. Information and collaboration siloes must be broken down before any progress can be made in working together to create a MaaS platform. Industry can play a role by setting well defined liabilities as well as agreed-upon actions and objectives.

The next step is to learn from existing and proposed MaaS projects as understanding innovative and new ideas is key to creating this platform. Utilizing examples posed in the case studies alone, the Austin deployment could learn several important lessons. Based on the first or second scenario the project champions could promote reaching out to differing case studies for support. If prioritizing an integrated payment MaaS platform, project champions would likely look to the NYC Late Shift Pilot, Whim in Helsinki, and Transit App. The NYC Late Shift pilot is working to create a platform where Uber or Lyft rideshares are able to be hailed and purchased within the MTA App. This case study could provide insight for working with stakeholders and bridging services by providers to create an integrated platform. Noting challenges of overcoming barriers to agencies working

collaboratively this case study can be used to understand ways of overcoming stakeholder communication and power barriers to create a functioning platform. Whim App in Helsinki could provide insight for government agencies to adapt to this new technologies in working with private agencies. After creating an ambitious transportation plan, Helsinki recreated the organization of their transportation department to establish a MaaS platform, in coordination with Forum Virium Helsinki and private organizations, similar to a relationship with research organizations like UT Austin. Lastly, Transit App is an existing mobility app that integrates transit services and other rides on demand. Transit App is a private organization that is used in cities around the world, Austin could learn from the private agencies in this platform in methods for reaching out to public agencies and coordinating services.

Alternatively, if deployment of MaaS in Austin focuses on creating a platform surrounding trip planning discussions would shift among case studies. First, reaching out to VIA in San Antonio would provide excellent insight into coordinating several mobility services. VIA provides locations and planning of the several mobility services available in the city, learning how VIA incorporated all modes of transportation into its trip planning would be beneficial for Austin. San Antonio is another Texas city that understands many of the statewide considerations that play into MaaS. VIA noted a particularly seamless relationship with Moovel to create GoMobile, this should be an information source for advice on the collaborative structure used for deployment. Following, Austin could also look at both Whim in Helsinki as well as Transit App for a further understanding of the

technology that provided the multi-modal trip planning service, and any lessons learned in its development and use.

Once leadership is established, formal goals are created for the MaaS platform along with specific challenges this platform aims to address, it is important to include public at this point. The fifth step includes this public outreach to the users of this platform, which will include both educational pieces as well as time to receive input. No matter the trip planning or integrated payment scenario is chosen, the format of the public outreach will stay the same though the messaging will change. These public meetings would likely be held at the Austin City Hall on a number of occasions, likely 2 or 3. At these meetings, it will be beneficial to break the attendees into focus groups that can foster discussion and information exchange. This meeting format can take many forms, one example is shown in Figure 23, using informational stands to present information. The information gathered at these meetings will ultimately be used to adapt the platform model to better suit the Austin community.

Figure 23. Public outreach within Austin. Source: AustinTexas.gov

Lastly, for the success of this deployment it is important to keep up to date on progress and comparisons with goals set. Here it is important to reference the benchmarks of each goal, whether this be to alter the average vehicle miles traveled for the average citizen by a certain date or see an increased amount of transit commuters by another date.

CONCLUSION

The City of Austin is in a unique position for implementing a MaaS platform, with many of the necessary pieces of infrastructure already in place, the city can expand this development to define and shape the future of its mobility. Austin is in a good position to deploy a MaaS platform in the future, between its thorough and progressive goals and plans and its existing online payment and planning platform. Between existing companies for online payment and ticketing, or small-scale deployments of MaaS, Austin has several groups to coordinate and collaborate with to learn from and gain assistance for successful MaaS deployment.

Chapter 6: Conclusion

Austin has made several strides in advancing its development from traditional American models of sprawling car-centric mobility. Encouraged by subsequent roadway congestion and reduced quality of life, the City advanced development goals of density and equity in mobility through several master plan. This PR defines MaaS as a single platform that includes all available mobility options within a municipality that a user can use for the entirety of planning and payment of a journey. Often MaaS is sought after for the goal of making mobility within an urban area easier than taking one's own car, benefits being reduced congestion, reduced GHG emissions, and enhanced mobility opportunities for residents that is made simpler.

MaaS platforms are highly complex, in that several stakeholders are at play, even outside what is traditionally considered mobility. There is a fine balance in organizing these stakeholders, all of which need to work together collaboratively and productively to produce a result that is in the best interest for its users. Several roadblocks and other stumbling points are at play here, including theoretical uncertainties such as user supply/demand forces, or the siloed nature across mobility providers. MaaS is especially difficult to deploy as the technology is so new and evolving so quickly that it is hard for many mobility providers to navigate this platform. This report identifies four main barriers to knowledge exchange, including organizational, workplace environment, available resources, and political barriers. Several researchers have proposed models for fostering this exchange, including incentives, or rewards, creating an atmosphere and time for reflection, and including outside sources, like UT Austin, as a research and moderating

group. It's been identified as important for mobility providers to distance from the "it's always been done this way" mindset, and to actively seek innovative solutions to promote MaaS, and to keep users' interested centered around this platform.

Three case studies were evaluated, including VIA in San Antionio that deployed GoMobile App, in partnership with Moovel. While not a fully functioning MaaS platform, this deployment covers many of its criteria and serves as a model for positive collaboration. Following, this PR evaluated the NYC Late Shift Pilot, that includes combined MTA and rideshare tickets all within the MTA App. This deployment is in the process of deploying and serves as a model for working through cross-platform trust building, and power relations. Lastly, this PR evaluated Whim App deployed in Helsinki in partnership with MaaS Global. This is one of the only fully functioning MaaS deployments in the world, deployed in 2017, and has shown to be a great success. This case serves as a useful case study in holistic and cross platform support, in an international setting.

Building out from both the essential elements list and necessary action items for MaaS deployment this paper evaluated opportunities for deployment within Austin. The city has shown pointed attempts at moving towards a multimodal urban fabric, including policies encouraging density, transit expansion, and an expanded bicycle network. Austin has proposed many documents encouraging this development, including the passage of the Austin Mobility Bond and Imagine Austin Comprehensive Plan. When comparing developments in Austin, the city is in a very good position to deploy a MaaS platform through careful consideration of knowledge sharing, data standards, achievable goals, and a comprehensive stakeholder dynamic.

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